4. User's Manual and Help System Requirements

Each ACM vendor is required to publish a compliance supplement or an independent user's manual which explains how to use the ACM for compliance with the Standards. The manual may also exist in electronic form, either on the user's workstation or web enabled. The document shall deal with compliance procedures and user inputs to the ACM. Both the ACM and the User's Manual and Help System shall positively contribute to the user's ability and desire to comply with the Standards and to the enforcement agency's ease of verifying compliance. The ACM User's Manual and Help System should minimize or reduce confusion and clarify compliance applications. The Commission may reject an ACM whose ACM User's Manual and Help System does not serve or meet these objectives.

4.1 Overview

The ACM User's Manual and Help System shall:

- Describe the specific procedures for using the ACM for compliance with the Standards.
- Provide instructions for preparing the building input, using the correct inputs, and using each of the approved optional capabilities (or exceptional methods) for which the ACM is approved.
- Explain how to generate the standard compliance reports and related compliance documentation. A sample of properly prepared compliance documentation shall be included as part of the manual or help system.

The ACM User's Manual and Help System serve two major purposes:

- It helps building permit applicants and others use the ACM correctly, and guides them in preparing complete compliance documentation to accompany building permit applications.
- It helps building department staff plan check permit applications for compliance with the Standards.

The ACM User's Manual and Help System serves as a crucial performance method reference in resolving questions concerning specific ACM program attributes, approved modeling capabilities and procedures in the context of both compliance and enforcement.

4.2 Modeling Guidelines and Input References

The ACM User's Manual and Help System shall contain a chapter or section on how to model buildings for compliance and how to prepare a building input file for a compliance run. The following are examples of topics to include:

- What surfaces to model (exterior, interior floors, etc.);
- How to enter data about these surfaces;
- How to model exterior shading (fins, overhangs, etc.);
- Appropriate zoning for compliance modeling;
- Selection of correct occupancy types;
- How to model similar systems;
- How to model buildings or portions of a building with no heating or cooling;
- Requirements for written justification and additional documentation on the plans and in the specifications for exceptional items;
- Program modeling limitations; and

- The *Nonresidential Manual* as required reading.

All program capabilities should be described in sufficient detail to eliminate possible confusion as to their appropriate use. While references to the ACM's regular users manual are acceptable, a complete listing of all inputs and/or commands necessary for compliance should be included in the ACM User's Manual and Help System.

4.3 Required Modeling Capabilities

4.3.1 General Requirements

4.3.1.1 Format

The ACM User's Manual and Help System shall be written in a clear and concise manner. The suggested format is:

- An introduction or overview explaining the use of the ACM for compliance with the Standards.
- A chapter or section which covers every input that can be used for compliance analysis.
- A chapter or section which covers each standard output report.
- Appendices, as needed, to provide any additional background information that are not crucial in explaining the basic functioning of the program for compliance. For example:
  - An appendix may contain variations of compliance forms as described above.
  - An appendix may include a series of construction assembly (ENV-3) forms to aid the ACM user.
  - An appendix may reprint important sections of the *Nonresidential Manual* or this manual that are crucial to modeling buildings correctly for compliance with the ACM.

Although the organizational format is not fixed, all information contained in the ACM User's Manual and Help System shall be easy to find through use of a table of contents, an Index, or through a context sensitive help system.

4.3.1.2 Modeling Guidelines

The ACM User's Manual and Help System shall contain clear and detailed information on how to use the ACM to model buildings for compliance with the Standards. Include the following:

1. Description of the value or values associated with each of input.
2. Restrictions on each variable.
3. Listing of the range beyond which inputs are unreasonable for any variable.
4. Description of options for any user-defined variable.

4.3.1.3 Statement

The following statement shall appear, in a box, within the first several pages of the ACM User's Manual and Help System:

> [Insert Name of Alternative Calculation Method] may be used to show compliance with California's Energy Efficiency Standards for Nonresidential Buildings only when the following reference documents are readily available to the program user:
>
> 1. 2005 Building Energy Efficiency Standards (P400-03-001F)
> 2. Nonresidential Manual (P400-03-004F)
>
> Both publications are available from www.energy.ca.gov org:

California Energy Commission
Publications Office
1516 Ninth Street, MS-13
P.O. Box 944295
Sacramento, CA 94244-2950
(916) 654-5200

4.3.1.4 Copies of ACM User's Manual and Help System

ACM vendors shall make a copy of the ACM User's Manual and Help System available to any California building department that requests it.

4.3.1.5 Commission Approval

Include a copy of the official Commission notice of the approval of the ACM. The notice may include restrictions or limitations on the use of the ACM. It will also include the date of approval, and may include an expiration date for approval as well. The notice will indicate optional capabilities for which the ACM is approved and other restrictions on its use for compliance. The Commission will provide this notice upon completion of evaluation of the ACM application.

4.3.2 Occupancies and Spaces

4.3.2.1 Conditioned Floor Area and Volume

Describe how the user determines and enters the conditioned floor area for each occupancy area and for the building as a whole.

- The conditioned floor area of all conditioned space (i.e., all directly or indirectly conditioned space) shall be included in the performance analysis. For a definition of conditioned space, see Section 101(b) of the Standards.
- All directly or indirectly conditioned volume shall be included in the analysis.
- State that the conditioned floor area for spaces within the building DO NOT include the area under permanent floor-to-ceiling height partitions, but that the conditioned floor area for the whole building includes the area under these partitions. This conforms with the Standards which define Conditioned Floor Area as the floor area (in square feet) of enclosed conditioned space on all floors of a building, as measured at the floor level of the exterior surfaces of exterior walls enclosing conditioned space.
- Note the following special cases:
    - For internal and enclosed spaces lighting power allotments for the Area Category Method are determined from floor areas:
    - Where areas are bounded or separated by interior partitions, the floor space occupied by those interior partitions shall not be included in any area.

4.3.2.2 Enclosed Unconditioned Spaces

Describe unconditioned spaces and that they are modeled using the same rules.

Explain that enclosed conditioned and unconditioned spaces shall be modeled if they are included in the permitted space and that modeling them is optional if they are not part of the permitted space.

If enclosed conditioned or unconditioned spaces are not modeled, the demising partition separating the conditioned space from the enclosed unconditioned space is modeled as an adiabatic partition (see Section 2.3.4.1).

4.3.2.3 Indirectly Conditioned Spaces

Explain that ACMs explicitly simulate all indirectly conditioned spaces, and that users may choose to simulate indirectly conditioned spaces as part of the directly conditioned space provided that the total volume and area of indirectly conditioned spaces included are each less than 15% of the total volume and area of the total indirectly and directly conditioned volume and area.

For the purpose of this manual, indirectly conditioned spaces are those that either can be occupied or cannot be unoccupied.

The requirements for each of these three cases are documented below.

Indirectly Conditioned Spaces Included in Directly Conditioned Space	Describe how the user enters this space. The space shall use the same configuration and occupancy characteristics as occurs in the construction documents, including envelope performance, occupancy characteristics and lighting levels.
Indirectly Conditioned Spaces that can be occupied and Explicitly Modeled	The ACM User's Manual and Help System shall describe how the user shall explicitly identify indirectly conditioned space which can be occupied.
Indirectly Conditioned Spaces that cannot be occupied and Explicitly Modeled	The ACM User's Manual and Help System shall describe how the user shall explicitly identify indirectly conditioned space which cannot be occupied. The ACM User's Manual and Help System shall instruct the user to specify the amount of light heat to be rejected to this space.

4.3.2.4 Light Mass

Describe how users enter parameters to approximate the mass effects of all interior partitions and furniture. When the ACM allows the user to enter information on lightweight mass,

Describe how to determine appropriate entries and restrictions on user entries for the spaces described below:

- *Directly Conditioned and Indirectly Conditioned Space Which Can be Occupied*: The reference method models lightweight mass through the use of "heavy" furniture weighing 80 pounds per square foot of floor area. In this method, there is an 85% chance that sunlight will fall upon furniture as opposed to the floor.
- *Indirectly Conditioned Spaces Which Cannot be Occupied*: For these spaces the reference method models lightweight mass by using a light furniture category of 30 pounds per square foot in DOE 2.1 to generate the lightweight standard weighting factors for these spaces.

4.3.2.5 Occupancy Types

Describe the use of each occupancy type in Table N2-2 for spaces or buildings when lighting plans are submitted for the entire building or when lighting compliance is not performed.

Include each area occupancy type from Table N2-3 for spaces when lighting plans are submitted for portions or for the entire building or when lighting compliance is not performed.

Require users to enter the occupancy(s) of each conditioned area or space being modeled. The user should select the occupancy that most closely matches the occupancy specified in Table N2-2 or Table N2-3. The user's occupancy selection should be based on the actual occupancy of the space(s) not on the amount of lighting or other energy use aspects desired.

Guide the user on how to determine an occupancy based on occupancy use similarities and limit occupancy lighting information and other occupancy assumptions to references to this Manual or an appendix. By virtue of the categories "all other" and "tenant lease space" the occupancy tables are complete and address all possible occupancies. The local enforcement agency (not the ACM user/permit applicant) has the discretion to determine if the user's occupancy choices are reasonable and correct.

If the ACM has an independent occupancy selection for ventilation, describe how best to select a ventilation occupancy and may describe ventilation assumptions.

Note. The ACM User's Manual and Help System is not the forum to argue the validity of area occupancy assumptions, nor should the ACM or the ACM User's Manual and Help System be written so that either encourages debates about area occupancy assumptions or debates about choosing occupancies based on these assumptions. The Commission strongly encourages vendors to reference these assumptions by referring to Chapter 2 of this manual, but these assumptions may also be provided in an appendix to the ACM User's Manual and Help System.

4.3.2.6 Mixed Occupancies

Explain how the user may select mixed as the occupancy type when selecting an area occupancy. Area occupancy types may only be mixed when they are all within the same zone, have the same operating schedules and when none of the occupancies includes process loads.

Describe how the user, if mixed is selected as the area occupancy type, enters the total area of the zone and the area and square footage of up to four different area occupancy types. Describe how the ACM automatically calculates the sum of the areas for the four different occupancies:

- If the sum of the four different areas is greater than the input total area of the zone, the ACM will abort or ask for corrected input.
- If the sum of the four different occupancies is less than the input total area of the zone, the ACM will assign the occupancy "all other" to the additional area needed to equal the input total area.

Note that the areas specified do not include the area of interior partitions for the purposes of determining lighting wattages in accordance with the standards.

Explain that the ACM will assign default assumptions for occupant densities, outside air ventilation rates, lighting loads, receptacle loads and service water heating loads by calculating the area weighted average for each of these inputs, using the areas input by the user.

Refer the user to sections for lighting, ventilation loads and process loads for respective requirements for each of these adjustments.

4.3.2.7 Occupant Loads

Explain that these values are automatically selected by the ACM based on the occupancy.

4.3.2.8 Receptacle Loads

Explain that these values are automatically selected by the ACM based on the occupancy type and that the receptacle loads include the process energy produced by equipment that are plugged into receptacle outlets such as personal computers and printers.

4.3.2.9 Process Energy

Explain that the process energy is limited to the energy produced by equipment whose locations are specified on the plans or other construction documents. The User's Manual and Help System shall clearly explain that the energy generated by plugged-in devices such as office equipment shall not be modeled as process energy. The thermal energy from such devices are included in the plug loads shown in Table N2-2 or N2-3.

4.3.2.10 Ventilation

Explain that the ventilation level is based on the selected occupancy(s) and cannot be altered by the user. The User's Manual and Help System shall explain that process ventilation may be input by the user for compliance simulations.

Inform the user that they shall justify the need for nonzero tailored ventilation values to the satisfaction of the local enforcement agency.

4.3.3 Walls, Roofs and Floors

4.3.3.1 Exterior Opaque Surfaces

Include the following information.

- Every exterior partition of the proposed building shall be modeled.
- The Standards define an exterior partition as: an opaque, translucent, or transparent solid barrier that separates conditioned space from ambient air or space that is not enclosed.
- Every slab-on-grade and underground walls and floors of the proposed building shall be modeled.
- Partitions separating the conditioned space from the courtyard are exterior partitions and shall be modeled as such by the ACM.
- Demising partitions are defined in the Standards as: solid barriers that separate conditioned space from enclosed unconditioned space.

Demising partitions may not be modeled as exterior partitions. They are modeled as interior walls constructed according to the plans and specifications for the building. If the enclosed unconditioned space is not included in the permit, the demising partition shall be modeled as an adiabatic partition for both the standard and the proposed buildings.

4.3.3.2 Interior Surfaces

The ACM User's Manual and Help System shall include the following information.

- All interior floors shall be modeled.
- Atria are considered indirectly conditioned spaces and partitions separating the conditioned space from atria are interior surfaces.
- All interzone and interior walls shall be modeled as air walls with no heat capacity and U-factor of 1 Btu/h-ft^2-^oF. The ACM automatically accounts for the heat capacity of all interzone and interior walls by modeling them as light mass.

4.3.3.3 Construction Assemblies

Explain how the user can select construction assemblies from ACM Joint Appendix IV, which will account for thickness (ft), density (lb/ft^3), specific heat (Btu/^oF-lb) and thermal conductivity (Btu-ft/h-^oF).

Note that the U-factor requirements for exterior partitions in the Standards include the fixed outside air film assumed in the Nonresidential Manual, but the reference method and other energy analysis computer programs extract this fixed outside air film value and recalculate the outside air film resistance on an hourly basis as a function of wind speed.

4.3.3.4 Absorptance and Emittance

Describe how the user enters the value for the absorptance and emittance for roofs (default shall be used for other surfaces), and describe the relationship between absorptance and reflectance (absorptance = 1 – reflectance).

Explain that the ACM user can specify roof surfaces between 0.90 and 0.20 absorptance and between 0.95 and 0.20 emittance, and that the program will warn and print an exceptional condition on the Certificate of Compliance whenever the absorptance is less than 0.50.

Explain the default for when the user does not specify an absorptance.

4.3.3.5 Surface Orientation and Tilt

Describe how the user enters the surface orientation (azimuth) and tilt of each exterior partition.

4.3.3.6 Exterior Doors

Explain how the user selects door constructions from ACM Joint Appendix IV and enters the orientation, tilt, locations, and areas for exterior doors.

Explain that exterior doors may be grouped together as one area if they have the same (within the tolerance allowed for ACMs) orientation, tilt, construction and materials.

4.3.3.7 Exterior Walls

Describe how the user selects wall constructions from ACM Joint Appendix IV, which account for U-factor and heat capacity. It shall describe how to enter the information to determine the Exterior Wall Area as:

Equation N4-1 Gross Exterior Wall Area - (Vertical Fenestration Area + Door Area)

where the Vertical Fenestration Area is equal to or less than the value explained below.

4.3.3.8 Underground Walls

Describe the parameters that users shall enter to model underground walls.

Require users to separately identify exterior walls separating conditioned space from adjacent earth, and request users to separately select underground wall constructions from ACM Joint Appendix IV.

4.3.3.9 Exterior Roofs/Ceilings

Describe how the user enters area, tilt and orientation of roof/ceiling constructions and selects a construction assembly from ACM Joint Appendix IV.

Describe how the user enters the information to determine the Exterior Roof/Ceiling Area as:

Equation N4-2 Gross Roof/Ceiling Area - Skylight Area

Describe how to enter each exterior roof assembly, including construction, orientation and tilt, location and area for all roofs as they occur in the construction documents. Exterior roofs that have the same construction assembly from ACM Joint Appendix IV and that are in the same occupancy and system areas and are exposed to the same outside conditions may be combined for the purposes of entering the area of the roof assembly.

4.3.3.10 Exterior Raised Floors

Describe how the user enters area and selects construction assemblies from ACM Joint Appendix IV.

Eexplain how the user enters raised floor construction/assembly information to simulate raised floors accurately.

4.3.3.11 Concrete Slab Floors on Grade

Describe how the user selects slab constructions from ACM Joint Appendix IV.

Provide the user with the information on how to enter slab constructions and areas as they occur in the construction documents.

4.3.3.12 Underground Walls and Floors

Describe the parameters that users shall enter to model underground walls and floors.

Require users to separately identify floors separating conditioned space from adjacent earth, and request users to select separate constructions from ACM Joint Appendix IV.

Require the user to enter underground floor constructions and areas as they occur in the construction documents.

4.3.4 Fenestration

4.3.4.1 Fenestration Products

Describe how the user enters information about the characteristics of fenestration products in both walls and roof/ceilings that affect the energy use of the building. The features that shall be explained in the ACM User's Manual and Help System are described in the following sections.

Describe the differences between the fenestration product categories: manufactured fenestration products, site-built fenestration products, and field-fabricated fenestration.

4.3.4.2 Fenestration Orientation and Tilt

Describe how the user enters the actual azimuth (direction) and surface tilt of glazing surfaces in each surface. The user shall be instructed that the azimuth and surface tilt of each glazing surface shall be entered as it occurs in the construction documents rounded off to the nearest whole degree.

4.3.4.3 Fenestration Thermal Properties

Describe that, for each fenestration product, the user shall input the fenestration's overall U-factor and SHGC.

Describe the allowed sources for the U-factor and SHGC, the fenestration labeling alternatives and the limitations on the use of the alternate default values as covered in Section 116 of the Standards and Section 10-111 of the Administrative Standards.

Describe that default values are used when no entries are made.

Explain that the basis of the standards is the appropriate maximum U-factor and the Relative Solar Heat Gain or the Solar Heat Gain Coefficient from Tables 143-A and 143-B of the Standards according to occupancy and climate zone.

4.3.4.4 Glazing in Exterior Walls and Shading

Describe how to model heat transfer through all glazed (transparent or translucent) surfaces of the building envelope walls. The user shall account for many features of exterior glazing in walls. These features, including all standard and proposed modeling assumptions and inputs, are described in the following sections.

4.3.4.5 Area of Fenestration in Walls and Doors

Explain how the user shall model the exposed surface area of each transparent or translucent surface. Fenestration surfaces include openings in the walls and vertical doors of the building.

Describe how to enter the following:

- *Fenestration Area in Walls and Doors*. For each glazing surface, the user shall enter the area of glazing surface associated with a zone. This area is the rough-out opening for the window(s). The areas of fenestration in walls and doors shall only be grouped when they have the same U-factor, orientation, tilt, shading coefficient, relative solar heat gain and relationship to shading from exterior devices such as overhangs or side fins. Fenestration in demising walls may not be grouped with fenestration in exterior walls or doors.

  The area of field-fabricated fenestration is limited to 1,000 ft^2 when a building has more than 10,000 ft^2 of total fenestration area; any building that exceeds this limit will not meet compliance.

- *Display Perimeter*. When the ACM calculates the standard glazing/fenestration area based on the display perimeter, the ACM User's Manual and Help System shall describe how the user enters parameters for display perimeter. The user shall specify a value, in feet, for each zone on each floor or story of the building that abuts a public sidewalk. The value is used as an alternate means of establishing Maximum Fenestration Area in the standard design (Title 24, § 143). As defined in Section 101(b) of the Standards, display perimeter is the length of an exterior wall in a Group B; Group F, Division 1; or Group M occupancy that immediately abuts a public sidewalk, measured at the sidewalk level for each story that abuts a public sidewalk.

- *Floor Number*. The ACM User's Manual and Help System shall describe how to determine each floor (story) of a building and how to determine if there is a Display Perimeter associated with each floor (story) of the building, and that a public sidewalk shall be surfaced with a material considered acceptable for sidewalks by the local codes, shall be readily accessible to the public view. Explain that the display perimeter is intended for applications where retail merchandise needs to be viewed by the passing public.

Explain that the *Maximum Fenestration Area* is 40% of the gross exterior wall area of the entire permitted space or building that can be occupied, or, if Display Perimeter is specified, the *Maximum Fenestration Area* is either 40% of the gross exterior wall area of the entire permitted space or building, or six feet times the Display Perimeter for the entire permitted space or building, whichever value is greater.

Explain that the *Maximum West-Facing Fenestration Area* is 40% of the gross exterior west-facing wall area of the entire permitted space or building that can be occupied, or, if Display Perimeter is specified, the *Maximum West-Facing Fenestration Area* is either 40% of the gross exterior west-facing wall area of the entire permitted space or building, or six feet times the west facing display perimeter for the entire permitted space or building, whichever value is greater.

4.3.4.6 Solar Heat Gain Coefficients of Fenestration in Walls and Doors

Explain how to determine solar heat gain coefficients and relative solar heat gains for fenestration in walls and doors, as defined in the Standards, and explain how and when each is used in modeling the characteristics of buildings.

Describe how and when the user enters solar heat gain coefficient from the Commission default Table or an NFRC label. This solar heat gain coefficient (SHGC) shall apply to the full fenestration area. Fenestration solar heat gain coefficient for each glazing surface shall be entered as it occurs in the construction documents for the building.

Explain to the user that the basis of the standards are the appropriate maximum RSHG values from Tables 143-A and 143-B of the Standards according to occupancy type, climate zone and orientation. Note that the maximum RSHG is different for north oriented glass; and that, for the purposes of establishing standard design RSHG, north glass is glass in exterior walls and doors facing from 45^{o} west (not inclusive) to 45^{o} east (inclusive) of true north.

For nonresidential buildings, high-rise residential buildings and hotels and motels, approved methods for accounting for the shading effects of site assembled, and field-fabricated fenestration assemblies are the information reported on an approved NFRC label, CEC's default table (Table 116-B of the Standards), and the value calculated in ACM Appendix NI or other Commission approved methods. This shading information which includes the effects of glass, framing and mullions applies to the entire window area. Effects such as the buildup of dirt on windows are not considered differential effects between the proposed and standard design which result in energy savings. These effects are intentionally neglected by the reference method and shall be considered the same in proposed and standard designs for ACMs.

4.3.4.7 Overhangs

Describe how users model overhangs over windows, including the following:

- *Overhang projection.* The distance the overhang projects horizontally from the plane of the window.
- *Height above window.* The distance from the top of the window to the overhang.
- *Window height.* The height of the top of the window from the bottom of the window, to which the overhang is applied.
- *Overhang Extension.* The distance the overhang extends past the edge of the window jams.

Instruct the user to simulate overhangs in the proposed design for each window as they are shown in the construction documents. Overhangs may not be grouped unless they are applied to windows facing the same direction with the same window height and the overhang has the same overhang projection, height above window, and the overhang is continuous from one window in the group to another.

4.3.4.8 Vertical Shading Fins

Describe how vertical shading fins are modeled.

Describe the constraints on the use of vertical shading fins, i.e. the fins shall be attached to the building. Objects that are separate from the building, such as adjacent buildings, may not be modeled as vertical fins.

4.3.4.9 Exterior Fenestration Shading Devices

Describe how the user enters parameters describing exterior fenestration shading devices.

Describe any restrictions on the parameters, i.e. the devices shall be attached to the building that the user is modeling for compliance.

4.3.4.10 Window Management

Describe how the ACM models window management and emphasize that this management is an assumption required for all ACMs, not a user option. The assumptions regarding window management include the effects of well-operated interior draperies.

Include the description of the proposed design assumptions that include interior drapes with a solar heat gain coefficient multiplier of 0.80.

4.3.4.11 Glazing or Fenestration in Exterior Roofs (Skylights)

Explain how to model heat transfer through all glazing or fenestration (transparent and translucent) in exterior roofs of the building envelope. The user shall account for many features of such glazing. These features, including all standard and proposed modeling assumptions and inputs, are described in the following sections.

4.3.4.12 Fenestration Areas of Glazing in Exterior Roofs (Skylights)

Describe how the user shall model the exposed surface area of each transparent or translucent surface, and shall describe how the user shall enter the proposed design fenestration areas as they are shown in the construction documents. Fenestration surfaces in roofs include openings in roofs and horizontal roof doors of the building.

Explain how the ACM determines the effects of these fenestration areas, including describing that:

1. When the Skylight Roof Ratio (SRR) in the proposed design is $\leq$ 0.05, the standard design shall use the same fenestration area as on each proposed design exterior roof.

   EXCEPTION: When skylights are required by Section 143(c) (low-rise conditioned or unconditioned enclosed spaces that are greater than 25,000 ft^2 directly under a roof with ceiling heights greater than 15 ft and have a lighting power density for general lighting equal to or greater than 0.5 W/ft^2) and the SRR in the proposed design is less than the minimum, the standard design shall have a SRR of 3.0% for 0.5 W/ft^2 = LPD < 1.0 W/ft^2, 3.3% for 1.0 W/ft^2 = LPD < 1.4 W/ft^2, and 3.6% for LPD = 1.4 W/ft^2 in one half of the area of qualifying spaces.

2. When the Skylight Roof Ratio in the proposed design is > 0.05, the ACM shall determine the horizontal fenestration area of the standard design by multiplying the fenestration area in each exterior roof by a fraction equal to:

   Equation N4-3 $SRR_{standard}/SRR_{proposed}$.

The U-factor and solar heat gain coefficients of individual skylights may be combined by area-weighted averaging only if they are not being used for daylighting and if they are in the same zone.

4.3.5 Lighting

Describe how users enter lighting parameters. The documentation shall describe how to enter lighting for each space being modeled.

Request the user to indicate one of the following conditions for the building:

1. *Lighting Compliance Not Performed*. Require the user to enter the occupancy type of each space from Table N2-2 or Table N2-3 of this manual. The documentation shall explain that Table N2-2 may be used even if the building has multiple occupancies.
2. *Lighting Compliance Performed*. Require the user to indicate whether lighting plans will be submitted for a portion of the building or for the entire building (excluding the residential units of high-rise residential buildings and hotel/motel guest rooms). If lighting plans will be submitted for a portion of the building, the documentation shall require the user to select the occupancy type of each space from Table N2-3 of this manual. However, if lighting plans will be submitted for the entire building, the ACM User's Manual and Help System shall require the user to select the occupancy type of each space from Table N2-2 or Table N2-3 of this manual. The documentation shall explain that for spaces without specified lighting level, the ACM selects the default lighting level from Table N2-3.

Explain that if the modeled Lighting Power Density (LPD) is different than the actual LPD calculated from the fixture schedule for the building, ACMs shall model the larger of the two values for the compliance run and shall print that value for "Installed Lighting" on the Certificate of Compliance.

Request the user to enter the Tailored Lighting Allotment and lighting control credits for each zone when they are applicable and the ACM uses those features. If a value is input for the Tailored Lighting Allotment, the user shall provide lighting plans that comply with the prescriptive requirements and all necessary Tailored Lighting Forms and Worksheets documenting the lighting and its justification.

Describe how to address lighting controls.

- If a value is input for lighting control credits, the user shall provide documentation that lighting control credits have been used in compliance.
- ACM Users may not take credit for lighting controls that would otherwise be required by the Standards, especially by mandatory requirements.
- For lighting controls required by 131(c)2 (either a multi-level automatic daylighting control or an astronomical multi-level time switch control), no credit is permitted for the minimally compliant control (astronomical multi-level time switch control), which is automatically modeled in both the proposed building and the standard building; however, if automatic multi-level daylighting controls are used, the proposed building benefits from an additional lighting power reduction.
- If the ACM allows the user to select from various types of lighting controls, warn users that the control type selected shall be installed in the entire floor area in the space or zone modeled in the program.

4.3.6 HVAC Systems and Plant

4.3.6.1 Thermal Zones

Describe the number of thermal zones (a minimum of fifty) that the ACM is capable of modeling and the minimum control capabilities that shall be included in each of these zones.

If a proposed building design has twenty thermostats or less, require the user to model the same number of zones as there are independent thermostats. Hence zones may only be combined when there are more than twenty (20) HVAC zones in a proposed building design. The methods of combining thermal zones shall be consistent with the definition ZONE, SPACE CONDITIONING in Section 101(b) of the Standards.

Explain the characteristics that will lead to zones being similar, so they may be combined into one zone for modeling purposes, and the characteristics that will lead to the zones being dissimilar. An example of similar zones may be central core areas on multiple floors of a multi-story building when they are served by the same system or systems of the same category. See Section 4.3.6.19 for combining like systems. An example of dissimilar zones may be a perimeter area on one facade of a building, part of which includes glazing and part of which has no glazing. The conditions in these two areas are sufficiently dissimilar that the areas should be treated as two zones (if they are independently controlled) even though they are on the same floor and facing the same orientation.

Emphasize that the distribution of heating and cooling shall be well balanced across any area that is to be considered as one zone.

Explain that zoning the building for compliance calculations shall be consistent with the actual zoning of the building if the actual zoning is known at the time of the analysis. If there are more actual zones than the program is capable of modeling, actual zones may be merged together for compliance purposes, as long as it can be established that the grouped zones are thermodynamically similar such that physical comfort could be maintained by a single thermostat or HVAC-controlling device/sensor.

Show that the ultimate test is to use non-coincident load calculations to show that actual zones grouped together for compliance calculations have the same or similar peak heating and cooling load profiles. This is done with a design load calculation which considers the peak load by month and hour.

Explain that physical zones which have the same or similar glazing orientation(s), the same or similar glazing area to floor area and the same occupancy types will be thermodynamically similar since, for example, they experience their peak cooling loads at the same hour. These zones can be merged together for compliance calculations.

Tell the ACM user that the standard design uses exactly the same zoning as in the proposed building design.

Describe how to zone a building that does not include an HVAC system in the design.

- Any building or separate permitted space smaller than 2500 ft^2 in conditioned floor area without an HVAC system or design may be modeled as having only a single HVAC zone.
- For buildings or permitted spaces 2,500 ft^2 and greater, each floor of the building shall be divided into multiple thermal zones according to the following procedure:
    1. Determine the ratio (R) of the floor's total conditioned area to the gross exterior wall area associated with the conditioned space.
    2. For each combination of occupancy type and exterior wall orientation create a perimeter zone. The floor area of each perimeter zone shall be the gross exterior wall area of the zone times R or 1.25, whichever is smaller.
    3. Model the exterior space adjacent to each wall orientation as a separate exterior zone. Spaces adjacent to walls which are within 45 degrees of each orientation shall be included in the zone belonging to that orientation.
    4. For cases where R is greater than 1.25, create an interior zone for each occupancy type. For each occupancy type, the floor area of the interior zone shall be the total area less the floor area of the perimeter zones created in paragraphs 2 and 3 above.
    5. Prorate the roof area and the floor area among the zones according to the floor area of each zone. Prorate the roof and floor areas among the perimeter zones created in paragraphs 2 and 3 above according to the floor area of each exterior zone.
    6. Assign skylights to interior zones. If the skylight area is larger than the roof area of the interior zone, then the skylight area in the interior zone shall be equal to the roof area in the interior zone and the user shall prorate the remaining skylight area among the perimeter zones based on the floor area.
    7. If the area of the zone is less than 300 ft^2, combine it with its adjacent zone of the same occupancy type and zone type (interior or exterior).
    8. Courtyards are considered outside or ambient air. Walls, floors, and roofs separating conditioned spaces from courtyards are exterior walls, floors, and roofs. Create an exterior zone for each wall orientation separating the conditioned space from the courtyard. The user shall not combine these exterior zones with other exterior zones even if their exterior walls have the same orientation.
    9. Model spaces adjacent to demising walls as interior zones. Combine these zones with other interior zones within the same occupancy type.
    10. Ignore all interior walls and model partitions separating thermal zones as air walls with U-factor of 1.0 $Btu/h\text{-}ft^2\text{-}^oF$.

Since the Commission considers a larger number of modeled HVAC zones to be a more accurate representation, the ACM User's Manual and Help System shall inform ACM users that the local enforcement agency may (at its own discretion) require the applicant to model additional HVAC zones.

4.3.6.2 Primary Systems

Include a list of the primary systems that the ACM can model.

Explain each required input parameter that is needed to describe each primary system, and shall explain how the user determines the appropriate input for any proposed design that will use the input.

Describe any constraints on each primary system, such as maxima, minima, ranges, or specific design applications.

4.3.6.3 Cooling Equipment

Describe how the user shall enter parameters that describe cooling equipment type, efficiency, capacity, or other parameters that are required to model the operation of the cooling system.

Describe to the user how to enter the number and names of zones served by the HVAC system so that the ACM may determine the use of single or multi-zone systems and so that the user correctly assigns each zone to an HVAC system serving it.

Describe how the user shall enter parameters that determine the required efficiency of the equipment, the efficiency descriptor that shall be used, and, when applicable, heat transfer fluid.

Describe each type of cooling equipment that the ACM is capable of modeling, and any constraints, such as maxima, minima, or ranges, that the user shall consider when modeling specific equipment.

4.3.6.4 Heating Equipment

Describe how the user shall enter parameters that describe heating equipment type, efficiency, capacity, or other parameters that are required to model the operation of the heating system.

Describe how the user shall enter parameters that determine the required efficiency of the equipment, the efficiency descriptor that shall be used, and, when applicable, the part load ratio and heat transfer fluid.

Describe each type of heating equipment that the ACM is capable of modeling, and any constraints, such as maxima, minima, or ranges, that the user shall consider when modeling specific equipment.

4.3.6.5 Standard Design System Selection

Include a description of the required user input for: building type, system type (especially single zone or multi-zone), heating source, and cooling source, so that the ACM and the reference method can properly determine the Standard HVAC System and Plant in the standard building design.

Explain the proper use of the ACM for compliance purposes.

Do not describe the standard design system types that are used to generate the standard design budget

Do not describe which system types in the standard design are used as the basis for comparison to proposed design system types. Such information may be included as a separate Technical Engineering Document for the ACM.

Describe any restrictions or limitations that the user should apply when entering parameters that describe the systems.

4.3.6.6 Cooling Efficiency of DOE Covered Air Conditioners

Describe how the user determines the proper efficiency descriptor for air conditioners that are Covered Consumer Products, and how the user shall enter these descriptors into the ACM.

4.3.6.7 Cooling Efficiency of Packaged Equipment not Covered by DOE Appliance Standards

Describe how the user determines the proper efficiency descriptor for packaged air conditioners that are not Covered Consumer Products, and how the user shall enter these descriptors into the ACM.

4.3.6.8 Efficiency of Cooling Equipment Included in Built-up Systems

Describe the required user input parameters for:

- Type of central water chilling plant equipment,
- The number of central chilling units,
- The capacity of each unit,
- The electrical input ratio of each central chilling unit,
- The type of refrigerant to be used in each chilling unit.

4.3.6.9 Heating Efficiency of DOE Covered Equipment

Describe how the user determines the proper efficiency descriptor for heating equipment that are Covered Consumer Products, and how the user shall enter these descriptors into the ACM.

4.3.6.10 Heating Efficiency of Equipment Not Covered by DOE Standards

Describe how the user determines the proper efficiency descriptor for heating equipment that are not Covered Consumer Products, and how the user shall enter these descriptors into the ACM.

4.3.6.11 Electric Motor Efficiency

Explain that the motor efficiency shall be determined as established in accordance with NEMA Standard MG1.

4.3.6.12 ARI Fan Power

Describe how users enter the fan power for each system type.

4.3.6.13 Process Fan Power

Explain that fans used exclusively for process shall not be modeled in the compliance run.

Describe how users shall subtract out the portion of fan power used for process if the fan serves a process as well as conditioning the space.

4.3.6.14 Fan System Operations

Describe the required schedules that are used for fan system operation.

Explain how the ACM models intermittent fan operation for the residential units of high-rise residential buildings and hotel/motel guest rooms.

4.3.6.15 Fan Volume Control

Describe the types of fan volume control that are available to the user, and any restrictions on the use of each fan system.

4.3.6.16 Design Fan Power Demand

Describe how the user enters parameters describing the fan power. These parameters shall include the design brake horsepower, the design drive/motor efficiency, and the design motor efficiency, all at peak air flow rate. The parameters shall be provided for each supply and each return fan.

Explain that if the user does not input the above required parameters, the ACM shall assume that no mechanical compliance will be performed and shall model the default mechanical system.

Explain how ACMs may combine return fans with the supply fan if and only if the controls are of the same type. For example, ACMs may combine fans if they all have variable speed drive control or if they all are constant volume fans.

4.3.6.17 Air Economizers

Describe when economizers are required and when they are used as the basis of the performance compliance.

Describe how to enter parameters describing the economizer and its method of operation.

Describe any restrictions on the modeling of economizers by the ACM.

4.3.6.18 Modeling Default Heating and Cooling Systems

Explain that the ACM automatically selects and models default heating and cooling systems identical to the standard systems defined in Chapter 2 (Standard Design Systems) for the following conditions:

1. Mechanical compliance not performed. The User's Manual and Help System shall describe what parameters shall be entered by the user to allow the ACM to select the proper default heating and cooling systems such as the building type and the number of thermal zones. The documentation shall explain the guidelines for zoning a building as described in Chapter 2.
2. Mechanical compliance performed with no heating installed. The User's Manual and Help System shall describe that the ACM automatically models the default heating system for spaces with no installed heating or spaces which use the existing heating system. The documentation shall also describe what parameters shall be entered by the user to allow the ACM to select the proper default heating system such as the building type and the number of thermal zones in the permitted space.
3. Mechanical compliance performed with no cooling installed. The User's Manual and Help System shall describe that the ACM automatically models the default cooling system for spaces with no installed cooling or spaces which use the existing cooling system. The documentation shall also describe what parameters shall be entered by the user to allow the ACM to select the proper default cooling system such as the building type and the number of thermal zones in the permitted space.

4.3.6.19 Combining Like Systems

Explain that users may model like systems together as one system provided the systems serve the same thermal zone or the thermal zones served by the individual units are similar and are being combined. The characteristics that lead to zones being similar are described in Chapter 2. The equipment being combined shall also all be of the same category.

A separate category shall exist for each change in efficiency standard level in the Appliance Efficiency Standards and in Section 112. These categories shall be listed in the supplement.

4.3.6.20 System Supply Air Temperature Control

Describe the control strategies that the ACM can model, and describe the parameters that the user shall enter to model these strategies. At a minimum, the ACM User's Manual and Help System shall describe strategies for constant supply air temperature when heating or cooling, and outdoor air reset for the cooling supply air temperature.

4.3.6.21 Zone Terminal Control

Describe when the user shall enter zone terminal control parameters, and how the user shall enter parameters for:

1. Variable air volume
2. Minimum box position
3. (Re)heating coil
4. Hydronic heating

5. Electric heating

Explain the criteria for minimum box position for variable volume systems.

4.3.6.22 Pump Energy

Explain that the ACM accounts for the pump energy for the hot water, chilled water, and condenser water piping systems.

For multiple pump systems, explain how to calculate the weighted average pump efficiency for the system.

Show the default values for the hot water, chilled water, and condenser loop piping systems.

4.3.6.23 Chiller Characteristics

Describe how the user enters chiller parameters that are required in the ACM, the chiller options that are available within the ACM, and the constraints on these parameters.

Show default values for the chiller options.

4.3.6.24 Performance Curves for Electric Chillers

Explain that the ACM allows modeling custom performance curves for electric chillers.

Describe the input requirements for calculating the regression constants for the chiller performance.

Explain that the ACM uses default performance curves if the user chooses not to make any entries.

4.3.6.25 Air-Cooled Condensers

Describe how the user is allowed to account for the characteristics of air-cooled condensers.

4.3.6.26 Cooling Towers

Describe how the user enters cooling tower parameters that are required in the ACM, the cooling tower options that are available within the ACM, and the constraints on these parameters.

Show default values for the cooling tower options.

4.3.6.27 Service Water Heating

Describe the parameters that the user shall enter to describe the water heating system, the efficiency of each water heater and the load that the water heater shall meet.

Describe that the user shall assign the load to individual water heaters when either more than one water heater is used to meet the load on one system, or when multiple systems are used in a building. When more than one water heater is used to meet the load for one system, the load distributed to each water heater in accordance with the following equation.

Equation N4-4

$$LOAD_k = LOAD_T \times \frac{OUTPUT_k + 453.75 \times VOL_k}{\sum_{m=1}^{n} (OUTPUT_m + 453.75 \times VOL_m)}$$

Where:

$LOAD_k$ = Portion of total load met by water heater k.

$LOAD_T$ = Total water heating load of system in Btu/hr.

$OUTPUT_m$ = Full load output capacity of water heater m.

VOL_m = Actual storage capacity in gallons of water heater m.

4.3.6.28 Duct Efficiency Calculation

Describe the parameters that the user shall enter to describe the air distribution system when Chapter 7 and ACM Appendix NG are used in conjunction with verified duct sealing.

4.3.7 Water Heating

Refer to Section 2.5, HVAC Systems and Plants for modeling requirements for service water heating systems.

4.4 Optional Modeling Capabilities

Provide detailed instructions on the documentation needed for optional capabilities, including instructions on how the ACM models the capability, which required capability will be used as the basis of the standard design for the capability, and any restrictions on the input values for the capability.

4.4.1 Additions and Alterations

Describe how users model additions, alterations, and additions plus alterations to the existing building.

4.4.1.1 Additions Performance Compliance

Explain that an addition is treated similar to a new building in the performance approach. Since both new conditioned floor area and volume are created with an addition, all systems serving the addition will require compliance to be demonstrated. This means that either the prescriptive or performance method can be used for each stage of the addition's construction.

Addition Only

Explain that additions shall meet the requirements for new buildings.

Explain that the user shall input all envelope, lighting and HVAC data associated with new conditioned space. If the HVAC zone serving the addition includes a portion of the existing building, prorate the capacity, fan power and cfm of the system serving the addition according to the design loads in the addition as compared to the loads in the whole zone.

Explain that if the permit is done in stages, the rules for each permit stage apply to the addition performance run. If the whole addition is included in the permit application, the rules for whole buildings apply.

Existing plus Addition

Explain that additions may also show compliance by demonstrating that efficiency improvements to the existing building offset decreased addition performance. Standards §149(a)2 states that the envelope and lighting of the addition, and any newly installed space conditioning or service water heating system serving the addition, shall meet the mandatory measures just as if it was an addition only. It also allows the applicant to improve the energy efficiency of the existing building so that it meets the energy budget that would apply to the entire building, if the existing building was unchanged, and the addition complied on it own.

Demonstrate that the existing-plus-addition analysis includes a calculation of the energy use of the existing building. In this approach, the following steps shall be followed:

a) Collect and document all information on the existing building before the addition and/or remodel.

b) Analyze the energy performance of the existing building before any changes take place.

c) Analyze the energy performance of the existing building plus the addition, including any alterations to the existing building.

d) The estimated energy use of the altered existing building plus the addition shall be less than the estimated energy use of an addition that complies with the prescriptive standards and the estimated energy use of the original existing building.

Explain to the user that when using this compliance approach, it is important to take into account all changes in fenestration, especially windows and skylights which are removed from or added to the existing house as part of the remodel. Credit may be gained in this context by insulating previously uninsulated parts of the building envelope.

Note for the reader the term "entire building" means the ensemble of all enclosed space in a building, including the space for which a permit is sought, plus all conditioned and space within the structure.

When using this compliance approach it is important to take into account all alterations in the buildings features that are removed from or added to the existing building.

Documentation of the existing buildings features is required to be submitted with the permit application if this method is used.

4.4.1.2 Alterations Performance Compliance

Describe how to use the ACM with alterations.

Alteration Only and Existing with Alteration

Explain that altered spaces that show compliance with the method independent of the existing building, shall meet the requirements for new buildings.

Explain that the envelope and lighting of the alteration, and any newly installed conditioning or service water heating system serving the alteration, shall meet the mandatory measures.

Explain to the user which building envelope measures may be modified in the existing building to obtain compliance credit. See Section 149 of the Standards.

If the permit is done in stages, explain that the rules for each permit stage apply to the alteration performance run.

Explain that if all the alterations' components, including the envelope, mechanical and lighting systems, are included in the permit application, the rules for whole buildings apply.

Explain that it is important with this approach to take into account all changes in the buildings features that are removed from or added to the existing building as a part of the alteration.

Explain that existing buildings features shall be documented and submitted with the permit application.

4.4.1.3 Alternate Performance Compliance Method

Explain that any addition, alteration or repair may demonstrate compliance by meeting the applicable requirements for the entire building.

Explain that the entire building could be shown to comply in permit stages or as a whole building. The rules for new buildings, and both permit stage compliance and whole building compliance would apply.

Explain that existing buildings features shall be documented and submitted with the permit application.

4.4.2 Alternative Occupancy Selection

4.4.2.1 Alternate Occupancy Selection Lists

Explain how to use alternate selection method for choosing occupancies.

4.4.2.2 Lighting Controls

The ACM User's Manual and Help System shall describe how to enter lighting controls, how to account for installed lighting and how to document the location and quantity of lighting on the appropriate forms.

4.4.2.3 Light Heat to Zone

The ACM User's Manual and Help System shall describe how to enter the light heat that goes to the zone and to the return air, how to account for the light energy, and how to document the type, location, and quantity of lighting fixtures for which this option is being modeled on the appropriate forms.

4.4.3 HVAC Systems and Plant

Include descriptions of all the optional systems that the ACM is capable of modeling. Optional systems that are allowed are described in Section 3.3.5.

Provide a detailed description of each optional system that is modeled, describe the system type that is used as the comparative standard design as described for minimum system capabilities, and describe any restrictions on the capabilities of each optional system.

Require the user of the ACM to provide manufacturers data, plans and specifications to document the assumptions used for each optional system.

4.5 Vendor Defined Optional Capabilities

Optional capabilities that are not described in this manual may be proposed by ACM vendors. Once the Commission has accepted a vendor defined optional capability, the ACM User's Manual and Help System shall include a description of how the user enters the appropriate parameters for the capability, a description of the documentation that shall be provided when using the capability, and a description of any restrictions that shall be applied when using the capability.

4.6 Compliance Forms

A chapter or section shall focus on how standard compliance forms are automatically generated and how to get diagnostic output when a building fails to comply (since compliance forms cannot be generated when a building fails to comply). ACMs shall print out the standard compliance forms with essentially the same format and layout to the standard forms. Mention should be made of:

- The requirement to document Tailored Lighting Allotments with lighting plans and prescriptive forms for each HVAC zone;
- The requirement to document Tailored Ventilation and/or Process Loads;
- The requirement to complete other forms for submittal when applicable;
- The requirement to document the zoning of the building if the zoning is not evident on the plans; and,
- Certificate of Compliance when applicable.

At least one sample of each compliance form shall be included. It is recommended, but not required, that the ACM User's Manual and Help System contain several sample variations of each compliance form as needed to illustrate different compliance scenarios and input types.